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THE ROLE OF CIVIL DEFENSE - 1986

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ABSTRACT

The technology of protecting people from nuclear weapons is well-developed and is being deployed by several countries including Switzerland, Sweden, Norway, Finland, the Soviet Union, and China. However, the United States, where most of the technology originated, has so far refused to make the investment necessary to provide significant passive protection for its citizens. Instead it has relied entirely on nuclear deterrence to prevent attack. The proposed Strategic Defense Initiative has reopened the debate on strategic defense.

The U.S. has several options for civil defense programs but the low-cost programs require several days warning for evacuation. A competent program protecting people in blast areas with only tactical warning would be cost effective at the margin with respect to offensive forces but would still cost 1% of the annual defense budget for 20 years. The fate of Reagan's attempt to expand the civil defense program suggests that this level of expenditure for passive defense is not politically feasible in the present climate.

Most knowledgeable observers believe that any active defense will leak, and that a passive defense underlayer will be required to reduce casualties from the leakage. It is possible that a decision to deploy active defense costing hundreds of billions of dollars (over 20 years) will make possible the expenditure of tens of billions of dollars for passive defense.

It is suggested here that a U.S. civil defense program will not make arms control more difficult. Most likely it will have little effect. It may provide some hedge against cheating, and make the corresponding risks in arms control agreements politically more acceptable.

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INTRODUCTION

President Reagan's proposal of March 23, 1983 for a Strategic Defense Initiative has reopened the debate on the role of active defenses in strategic arms policy. Questions concerning the technical feasibility of active defense, its effect on crisis- and arms-race stability and its interaction with arms control are all being vigorously discussed. Indeed, it is one of the purposes of this conference.

Curiously, passive defense has hardly been mentioned in the debate. By passive defense we mean civil defense; the array of shelters and other measures that protect people and in some cases industry against destruction by nuclear weapons.

The purpose of this discussion will be a review of the state of the art and status of civil defense, followed by some speculations on its potential interaction with the Strategic Defense Initiative and implications for arms control.

STATUS OF PASSIVE DEFENSE TECHNOLOGY

The belief is widespread in western intellectual circles that protection of societies against the effects of nuclear weapons by passive means is impractical to impossible. As a result, the United States depends exclusively on a strategy of deterrence to protect its population. This view is not shared by its adversary, the Soviet Union.

The technology of protecting people against the blast, heat, and ionizing radiation from nuclear weapons is 30 years old. It evolved from the technology for protecting personnel from aerial bombs and artillery shells developed before and during World War II. Only the technology developed in the West is in the open literature and available to everyone.

The technology exists to protect people and installations directly under the crater of a surface-burst megaton-range nuclear weapon. This approach, which consists of very deep (1 kilometer or more) steel-lined reinforced concrete tunnels is very expensive and can only be afforded for extremely high value military targets. Costs of such structures can exceed tens of thousands of dollars per occupant sheltered.

To be practical, shelters for civilians must be constructed for a much lower cost, well under \$1000/space. This is because blast shelters are required for large populations in the areas believed to be at risk. In the United States, this could be as many as 160 million people.

Blast shelters, particularly when buried, have costs which are relatively insensitive to overpressure over the range of 10-100 psi. An overpressure of 50 psi ($3\frac{1}{3}$ atmospheres) would be experienced 1 mile from a low air-burst 1-megaton explosion. It is also the overpressure experienced directly under a 1 megaton explosion burst at a height to maximize the area covered by approximately 20 psi which would destroy industrial assets.

The most economical scheme we have encountered for the production of large numbers of shelter spaces for civilians is the "hardening" or "blast-slanting" of building basements in new construction (Murphy, et al, 1975). This would entail constructing over the basement a concrete first floor 12-24 inches thick which is reinforced and supported to provide the strength to resist the design overpressure. The basement

would have to be equipped with blast doors on its entrances, ventilation protected against blast and rubble, and a water supply. An incremental structural cost as low as \$200/space has been estimated for this type of shelter.

The one pilot experiment that has been done cost \$608.70/space (Shaw 1985). However, it was not the lowest bid. This structure was designed for 15 psi. The design withstood 50 psi in subsequent model tests. The pilot experiment demonstrated that present design manuals are inadequate, and many institutional problems must be solved before a blast-slanting program can be launched.

The cost-effectiveness of permanent shelters with respect to offensive weapons to neutralize them depends on the cost per space for the shelter, its hardness, and the population density sheltered. The higher the density the more advantage the offense has. With present weapons systems costing about \$20 million per megaton equivalent* the cost trade-off favors the defense (i.e. shelters) below a population density of about 12,000 people per square mile for 50-psi shelters costing \$500/space.

The trend toward lower yield warheads (100-200 kt in systems such as the cruise missile), requires that shelters designed for 30-50 psi must also be specifically designed for initial nuclear radiation. In the case of hardened basements, first floor thicknesses of 24-36 inches may be required, depending on the shielding mass of the building above the basement.

* A megaton equivalent is a collection of warheads that can cover the same area with any given overpressure as a single one-megaton weapon. The megaton-equivalent of a weapon is equal to its design yield in megatons (or fraction of a megaton) raised to the $2/3$ power. The megaton equivalent of a strategic force is the sum of megaton equivalents over all the warheads in the force.

In high-rise business districts the production of rubble from the buildings and the possibility of fires producing carbon monoxide present very difficult design problems for isolated shelters. Entrances and ventilation air intakes can be deeply buried in rubble. Burning or smouldering of combustible materials in the rubble can contaminate air pulled through it with carbon monoxide. If shelters are built in these areas they must be connected to tunnels leading out of the high-rise area and connected to air intakes in relatively open areas.

In the last 15 years a technology of "expedient shelter" has been developed. This term is used to describe fallout or blast shelter which can be constructed with tools and materials at hand. Typically such shelters are earth-covered trenches. Other designs are possible for regions of high water table. Extensive construction and occupancy experiments have demonstrated that these shelters can be built by untrained American families in 24-48 hours using only written instructions.

All these shelters provide excellent protection against thermal effects and fallout, and some protection against blast. Fallout protection factors of 200 are easy to achieve. Shored covered trenches will survive 10 psi or more. (One design specifically developed for blast hardness has been repeatedly tested at more than 50 psi).

The most important aspect of these shelters, after their effectiveness, is that they require no pre-crisis investment in materials and labor. These shelters are constructed from materials available in and around most American suburban and rural homes: closet doors, bedsheets, wood poles, and shower curtains.

The field-tested instructions for shelter construction, as well as other important survival information has been published and is commercially available (Kearny, 1979), (400,000 copies have been sold). In a crisis

this information could be rapidly disseminated by newspapers. In theory, at least, if warning is available, a means exists to protect most Americans against the effects of nuclear weapons, within the present budgets for civil defense.

One of the advantages of passive defense technology is that it is mature and believed to be relatively invulnerable to technological surprise. Weapons effects are well known and understood. From time to time "new" environmental effects are claimed, such as nuclear winter or ozone depletion. On close examination the effects turn out to be much smaller than originally claimed, and do not significantly alter the problems that must be faced by the nuclear combatants.

Biological weapons offer the possibility of an "end run" around shelters against nuclear effects. The inhabitants of shelters without a filtered air supply can be killed by biological weapons requiring about the same delivery capacity as for nuclear weapons producing the same casualties by blast. However, air filtration capability adds relatively little to the cost of permanent blast shelters, and the technology is well understood (Chester and Zimmerman, 1984).

Chemical weapons require more elaborate air filtration equipment. However, they are unlikely to be used on any large scale in inter-continental strategic warfare because they require 10,000 to 100,000 times the throw weight capability as nuclear or biological weapons producing fatalities over the same area.

FOREIGN CIVIL DEFENSE PROGRAMS

In stark contrast to the United States several foreign countries have undertaken ambitious and highly effective civil defense programs. Of these Switzerland is clearly the leader having spent something of the order of \$30/person/year for the last 20 years on civil defense. In

contrast the United States presently spends \$0.55/person/year. The backbone of the Swiss program is shelter construction. For the past 25 years Swiss law has required that each new building have a blast shelter in the basement capable of protecting the building occupants against at least one atmosphere blast pressure. Other shelters depending on location may be required to have 2 or 3 atmospheres protection (Cristy, 1974). They presently have shelter for 90% of their population (Royal United Services Institute, 1982).

Finland has a similar program and claims to have protection for 48% of their population. Sweden and Norway have shelter construction programs which emphasize the construction of dual-use community shelters as well as private shelters. Very often these are constructed by excavation of space in the competent granite rock widely prevalent in those countries.

The Soviet Union has a major civil defense program consisting of super hard shelters provided for high political leaders and approximately 3-atmosphere shelters for the critical workers. There are basement shelters in some residential apartment buildings. Protection for non-essential civilians depends heavily on plans to evacuate target areas. In the event of a crisis the evacuees would construct expedient shelter or upgrade basements in the reception areas (Akimov, 1971). The Soviet Union is believed to spend something of the order of \$12/person/year on civil defense.

In marked contrast to western countries, the population of China is approximately 80% rural and can be readily protected with expedient fallout shelter. Starting in 1968, China began to construct networks of blast-hardened tunnels under many of its cities. The tunnels were inter-connected and connected to many underground rooms which are used for compatible peacetime uses such as cinemas, hospitals, and cafeterias. The tunnels extend well outside of the cities which permits them to be used to evacuate the cities. They are also intended to be

used for tactical movement of troops in the event of fighting in and around the cities. One reason China was able to afford this very elaborate shelter system is that the construction involved a very large component of volunteer labor in the construction, working evenings and weekends.

All of the large programs in other countries also have training programs for the population, food and water storage, radiation instrumentation, and the other necessary infrastructure.

There appears to be a re-awakening of interest in civil defense in the United Kingdom, France, and Germany in the last 2 or 3 years.

STATUS OF THE U.S. PROGRAMS

The Reagan Administration attempted to expand the Carter program of Crisis Relocation Planning by adding an industrial protection component. Among other things, the proposed Reagan program would have included construction of about 4 million shelter spaces for workers in critical industries to maintain production and essential services during an evacuation. The Reagan effort was defeated by congress and is now in a holding pattern awaiting a review of the program. Spending in real dollars in fiscal 1986 is lower than at any time since civil defense was started in 1950.

The present program still possesses some assets as a result of work in previous years. These include a register of fallout shelters encompassing approximately 245 million spaces with protection factors greater than 40. Unfortunately, most of these spaces are located in risk areas and only 35% are in basements. Much of the space in upper floors in multi-story buildings is extremely vulnerable to very low levels of blast overpressure. Most spaces have no ventilation if power is not available and lack water storage, food, radiation meters,

sanitation facilities, or any other logistic support necessary to support a population for two weeks.

Crisis relocation plans have been completed for about 1500 out of 3000 communities in the United States encompassing approximately 30% of the population. At present there are no plans for a federally directed evacuation capability. What planning has been done would be used in the event of a spontaneous evacuation in an escalating crisis. Such planning for food supply for an evacuated population as has been done depends on warehouses and distribution centers in target areas. At the present time there are no plans to feed the population which can function after a nuclear attack.

Given the political and budgetary realities which exist in the U.S. at the present time, a self-help program is being considered (Becton, 1986). This would relegate FEMA to a provider of information to local organizations and individuals. Information on the threat and optional countermeasures might be provided. It is expected this program would make extensive use of volunteer organizations and would depend on spontaneous evacuation and the construction of expedient shelter for the protection of risk area population. There would be emphasis on planning for the survival of state and local government organizations.

There is a fairly good attack warning capability through the emergency broadcast system and the NOAA radio weather warning system. There is some radiological defense capability consisting of some people trained to use radiation detection instruments and an inventory of 660,000 survey instruments and 2.7 million dosimeters which are maintained. There are a variety of regional, state and emergency operating centers some of which are blast-hardened or have fallout protection. The locations of the protected centers have been public information for years and it must be assumed that at least regional and state centers would be targeted.

The existing U.S. civil defense program is little more than a standby or cadre program as far as attack preparedness is concerned. Not very much real capability can be purchased for 55 cents per capita per year.

U. S. CIVIL DEFENSE OPTIONS

An infinite number of civil defense programs are possible, given the possibilities for providing shelter, the degree to which evacuation is employed and the variations possible in budget. However, it is possible to divide them into four alternatives with ascending budgets.

Ultra-Low Cost

One possible ultra-low cost program is the present program costing slightly over 100 million dollars a year. No funds are available for construction. The budget goes for maintaining an organization and providing information. This program would make use of the best available shelter (basements) in the event of an attack preceded by little warning. In the event of strategic warning it would make heavy use of evacuation with expedient shelter and basement upgrading in the host area. With good planning and a good information program this option can provide significant protection if and only if there are several days of unambiguous warning.

Low-Cost Program

A program costing a total of 6-8 billion dollars over 20 years can provide good protection for the population outside of the risk areas even with little warning. Good protection for the risk area population is possible only if there is enough warning of the attack to permit evacuation. The program would consist of fallout protection designed into new construction outside the risk areas.

Where the geology is favorable, some shelter could be produced in the vicinity of some cities by converting open pit quarrying operations for concrete aggregate to underground mines.

While the cost to the economy of such a program might be in the neighborhood of 8 billion dollars, perhaps only half need show up on the Federal budget. The rest would be absorbed by increased cost of the construction and mining involved.

Medium-Cost Program

A medium-cost program costing in the neighborhood of 40 billion dollars spread over 20 years might consist of blast protection designed into new buildings in risk areas in addition to fallout protection in new buildings in host areas described above. This program would provide a considerable degree of protection to the risk area population even in the event of very little warning of an attack. Very high density, high-rise business districts could not be protected in this option and would require evacuation (or failure to show up for work) of a small fraction of the population. Where possible, incentives would be provided for underground building construction. The fraction of the 40 billion cost appearing on the Federal budget would depend on whether the program was funded by federal taxes or by the new building owners. This program would cost the economy approximately 1% of the U.S. defense budget annually.

A High-Cost Program

A high-cost program would include all the previous program elements and, in addition, tunnel shelters under the very high-density central business districts. Keyworker shelters and construction of some single-purpose retrofit shelters in areas where building turnover rates are too low would be required to provide the necessary shelter in 20 years. Cost of this program might be in the neighborhood of 100 billion

dollars, perhaps 2% of the defense budget over 20 years. It would provide good shelter on short notice to everyone at any time of the day or night.

The failure of the Reagan attempts in 1982, 1983, and 1984 to double the civil defense budget suggests that the medium and high-cost options are not feasible in the present political and economic climate in the United States. For these options to become practical that climate would have to change. It is conceivable that a successful SDI leading to a defense-oriented strategic policy could effect that change.

INTERACTION OF CIVIL DEFENSE WITH ACTIVE DEFENSE

If a defensive system could be constructed that lets through only one warhead in 10,000, a goal of SDI, a shelter program is not cost effective. However, credibility of a system with this level of performance is not likely even if it performed to that level in peacetime exercises. Few people would believe that it would perform as well under the stress of a mass attack. In addition SDI is designed only to deal with ICBM-delivered warheads. There are still bombers, cruise missiles, and smuggled nuclear weapons to worry about. A civil defense underlayer costing perhaps 10% of the active defense can reduce the casualty producing effectiveness of incoming weapons by 90% or more. With a good shelter system the population is largely taken out of the game and in effect becomes spectators in the battle over industry. Much lower performance active systems would become interesting under these circumstances.

An active defense helps passive defense in a number of ways. First, and most obviously, the weight of the attack is reduced, reducing the number of hits the shelter system has to protect against.

With an active defense the attacker has more of an incentive to airburst his weapons in order to make the surviving weapons cover more area and to reduce the time the terminal defense has to intercept the arriving warheads after atmospheric re-entry. Nominal 50-psi shelters completely eliminate casualties among their occupants from weapons exploded at an altitude to optimize area coverage by 20 psi overpressure.

Civil defense has very limited capability to protect industry. A successful active defense protects everything including the most fragile industrial plants. Even a partially effective active defense introduces enormous uncertainty in the attacker's planning. The attacker can never be sure that any given target or set of targets can be completely destroyed. It then becomes difficult to impossible for an attacker to design attacks intended to bottleneck the economy by producing very high levels of destruction to certain critical industries such as oil refining or electric power, for example. Survival of very small amounts (3-10%) of critical industries can enormously accelerate post-attack recovery compared to the situation where all of these critical industries are destroyed (Laurino and Dresch, 1971). The likelihood of having a surviving core of vital industry makes the whole concept of post-attack recovery and population survival much more credible.

Perhaps the greatest contribution an active defense could make to passive defense is to change political thinking about what are reasonable levels of expenditure for defense. An active defense system costing hundreds of billions of dollars may well make a passive defense system costing tens of billions of dollars politically viable.

ARMS CONTROL AND CIVIL DEFENSE

The suggestion that civil defense programs can influence an adversary's strategic weapons procurement is not strongly supported by the experience of the U.S. and Soviet Union. Starting in the early 1960's

the Soviet Union has deployed a massive program to protect its population and industry. Over the same period the United States has allowed its nuclear throw-weight to fall. Over the same time period the United States civil defense program has steadily declined while the Strategic Rocket Forces of the Soviet Union have undergone massive expansion in terms of throw-weight as well as other capability.

In the mid-1960's the criterion of deterrence announced by then Secretary of Defense McNamara was the destruction of 20% of the population and 50% of the industry. In the mid-1970's the U.S. strategic community became aware of the Soviet Civil Defense Program, particularly their evacuation plans. The U.S. criterion of population casualties was then abandoned and announced targeting priorities were shifted to government control and economic recovery assets. The U.S. neither increased the weight of its strategic offensive forces nor in any significant way increased the size of its civil defense program. Instead a review of civil defense was undertaken which led eventually to Crisis Relocation Planning (Sullivan, et al, 1978).

From this we can conclude that significant improvements in U.S. civil defense programs are unlikely to be arms race destabilizing, i.e., to provoke a further expansion of Soviet strategic offensive forces.

The same cannot be said for active defense. Both critics of SDI and Soviet officials have predicted a large expansion in Soviet strategic offensive forces as a response to U.S. deployment of a competent active defense. While civil defense measures do not threaten the counterforce capability of the Soviet offensive forces, active defenses do. Since the Soviets have never claimed to target population per se, a U.S. civil defense program also does not threaten the Soviet deterrent as they perceive it. The civilian targets of Soviet war fighting strategy are those fixed industrial assets that provide logistic support to the armed forces, including production capability for nuclear weapons. It will be

noted in passing that any arms control strategy or plan must take into account the asymmetry between U.S. and Soviet strategies and perception of security. Soviet strategy and concept of deterrence is not based on the concept of punishing the enemy, but on prevailing over him in a conflict. Their active and passive defense and offensive forces are tailored logically to war fighting and war survival (Goure, 1976). For many years the announced U.S. policy has been one of deterrence and only in the last few years have considerations of Soviet values appeared in statements on national strategic policy.

Not all civil defense programs are crisis stabilizing. Herman Kahn, (1961) among others, has pointed out the parallels between a civil defense program based entirely on evacuation and the mobilization of the antagonists that preceded World War I. Once in the evacuated or mobilized posture the nation's vulnerability to attack is greatly decreased. Unfortunately, the economy is also shut down or severely restricted and a nation's ability to maintain the posture is severely limited. In the case of civil defense evacuation, the fix is to make provision for maintaining production of critical industries; those which support the military and provide logistic support to the population. The Soviet Union includes this feature in their civil defense plans. Blast shelters are provided at critical industrial locations for the onshift workers (Goure, 1976). The workforce would commute between the host areas and risk areas. The Reagan Administration attempted to ameliorate this shortcoming of the Carter Administration's "D-prime" (evacuation) program with the development of its Industrial Protection Program. Administration proposals for a budget to effect this program were defeated 3 years in succession by Congress. The main reasons were Congressional disbelief in the feasibility of evacuation of large cities, and the 4 billion dollar price tag for 4 million shelter spaces for critical workers.

A really credible civil defense program might improve the political acceptability of the inevitable risk taken in any arms control or arms reduction. The effect of a good shelter program is to shrink the casualty-producing capability of the adversary's warheads and hence impose some arms reduction on the enemy. In effect civil defense provides some hedge on cheating.

It should be noted that in order to be perceived as competent, the civil defense program must deal not only with the issue of shelter against blast effects, but the longer term survival and recovery efforts as well. Particularly needed is a believable program to make the large supplies of stored U.S. grain available in a timely manner to the high population areas of the country after a nuclear exchange.

The political acceptability of a defensive strategy with a goal of national survival should increase the political value of actual reductions in strategic offensive arms which are the goals of arms control policy. In the present widespread belief in the massive overkill capability of strategic offensive forces, reductions in offensive forces are not perceived as significantly improving anybody's chance of survival. They are perceived as improving the diplomatic climate and possible reducing expenditures on nuclear weapons. Improvements in diplomatic climate have proved to be ephemeral and reductions in nuclear weapon expenditures have proved to be chimerical.

It is obviously true that significant reductions in strategic offensive arsenals contribute greatly to the functioning of civil defense. Whether these reductions are accomplished by active defense systems or arms control/reduction agreements matters little to the passive defense system (although a great deal to the taxpayers).

There is a danger that we may delude ourselves about our own cleverness in active defense technology or in the institutional arrangements of arms control agreements. We may think we have foreseen every contingency and provide carefully reasoned arguments or even sophisticated computer-generated fault-trees to prove it. Reality has demonstrated the perverse ingenuity of human and technological failures in finding oversights in these analyses. Catastrophes involving the Challenger space shuttle and the Chernobyl nuclear plant are only the most recent examples.

Postulated multi-layer active defense systems sought by the SDI, and the institutions, political systems, and personalities involved in arms control agreements are immensely more complicated than space craft or nuclear reactors. Common prudence, in addition to simple humanitarianism would seem to suggest that we ought to take some steps to protect people in the event that deterrence, or defenses, should fail. For a very small fraction of the defense budget, we can prevent scores of millions of deaths in the event of catastrophe and improve the chances for ultimate recovery. Perhaps, given a second chance, the survivors of such a chastening experience would be more successful in establishing effective nuclear arms control or other mechanisms to keep the peace.

CONCLUSIONS

Civil (passive) defense would appear to be indispensable as the foundation on which all programs leading to a defensive strategy must be built. By shrinking the size of the enemy's warheads in casualty-producing capability it is in effect a form of arms reduction. It would appear to be a very valuable form of insurance against less-than-desired performance of active defense systems or cheating on arms control agreements. As discussed above, civil defense has been experimentally demonstrated not to destabilize competition between the two Super Powers in acquisition of strategic offensive weapons.

Because of the huge numbers of people that must be protected, any competent program of civil defense is going to be expensive. By competent, here we mean protecting people against blast with only tactical warning of an attack. Because of this cost and perhaps more importantly because of the widespread belief in the futility of any nuclear defense, civil defense has not been accepted by the U.S. political system. These political difficulties may be overcome if SDI results in an economically and technically feasible active defense which is then deployed. Nuclear war survival would then become a credible concept. The expenditures necessary for a competent civil defense would then become politically practical.

Given the U.S. perception of and response to the Soviet civil defense effort, it is difficult to argue that a U.S. civil defense program would make any arms control efforts more difficult. In the most likely case it won't have much effect. It may provide some hedge on cheating. A manifestly competent civil defense program might make risks in arms control agreements politically more acceptable.

Given the uncertainties in the world and the existence of nuclear weapons it would seem that a system to protect our population against their effects would be a prudent and humanitarian thing to do. The cost would be large, in absolute terms but only a tiny fraction of what we currently spend for defense. It should be justifiable on its humanitarian merits only and not require that it be part of some larger scheme of active defense and/or arms control. However, given the present economic and political climate, deployment of a competent U.S. civil defense is unlikely unless it is part of a larger strategy, or unless the political climate changes as the result of some catastrophe.

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